

**Institution: Loughborough University**

**Unit of Assessment: C14**

## 1. UNIT CONTEXT, RESEARCH AND IMPACT STRATEGY

Loughborough University's commitment to geographical research has been marked by **substantial institutional investment since 2014**, with a 14% increase in REF1a staff, £1.5M investment in a new purpose-designed building with state-of-the-art laboratories, and £2.3M investment for events, partnership development, PhD studentships and pilot research funding. This support has led to a **280% increase in external research income**, significantly greater international recognition, for example the award of major medals from the Royal Geographical Society, European Geosciences Union and American Association of Geographers, and an outstanding and improved leadership profile, including leading the Foreign, Commonwealth and Development Office's (FCDO) £39.8M Modern Energy Cooking Services programme, **Loughborough's largest ever single research award**.

### 1.1 Research Structure

Our submission comprises all 36 staff (34.4FTE) in Geography and Environment (GYE), one of five Units within the School of Social Sciences and Humanities (SSH). SSH is one of nine Schools at Loughborough with its own School Research and Enterprise (SREC) and Senior Management Committees. GYE is represented on these committees through, respectively, its Research Director and Head of Unit who develop policy for research and impact in line with the University's "*Building Excellence*" Strategy (2014-2020), working with the Dean and Associate Deans for Research and Enterprise. The Dean (Smith) and Associate Dean for Research (Rice) are from GYE, demonstrating a significant leadership contribution to SSH.

Our research is organised around six research themes:

1. Cities
2. Children, Youth and Families
3. Climate-Water-Energy
4. Hydroclimate, Risks and Resilience
5. Migration and Nation
6. Understanding and Managing Environmental Change

These include themes where we have a distinctive established reputation (e.g. *Children, Youth and Families*) alongside rapidly emerging areas of growth (e.g. *Climate-Water-Energy*).

SSH was reorganised and enlarged during this REF period to better support **interdisciplinary research**, combining GYE with Communication and Media, English, Politics and International Studies, and Social and Policy Studies. This fostered new connections and enabled new international research, including SSH's £453k ESRC-Colciencias *Territorial Planning for Peace and State-Building in Colombia* project, led by Gough in partnership with specialists in peace and conflict studies, and social design.

The 'CALIBRE' strategic research framework drives interdisciplinary activity across the University. GYE plays a pivotal role with leadership and influence in all four multidisciplinary "Global Challenges":

- *Energy* – Brown is Deputy Director
- *Changing Environments and Infrastructure* – Wood is Director
- *Health and Wellbeing* – Gough is GCRF lead
- *Secure and Resilient Societies* – Smith is Deputy Director

In addition, Watson and Antonsich are theme leads for 'Culture, Economy and Policy' and 'Migrations and Nations' within the *Communication and Culture* "Beacon's" flagship Centre for Research in Communication and Culture.

GYE capitalised on these interdisciplinary structures, collaborating with seven of Loughborough's eight other academic schools on externally funded research projects, outputs and PhD supervisions. This included Loughborough's £1.4M ESRC-Innovate UK *Technology Driven Next Generation Insurance* project which saw human and physical geographers (van Meeteren, Hillier) collaborate with colleagues in the School of Business and Economics, and systems engineers in the School of Mechanical, Electrical and Manufacturing Engineering.

## 1.2 Review of Objectives and Research Plans in REF2014

Following REF2014, we undertook a systematic review of research strategy and structures. Underpinned by a mapping of established and emerging strengths, key outcomes were:

- Explicit emphasis on building research excellence, raising aspiration and embedding impact in a revitalised Research and Impact Strategy for 2014-2020.
- Reorganisation from four mutually exclusive clusters to six integrated and agile themes that better represent our research priorities and practice.

This Strategy set out three broad research objectives:

- To produce outstanding research at the forefront of developing new geographical knowledge and research agendas.** This was supported by the introduction of School and University Fellowships; improved mentoring and monitoring processes; and raising aspiration via a revitalised Performance and Development Review (PDR) process. Delivery of this objective is evident in an £8.1M increase in research income and a 240% increase in the number of articles published in high-visibility, discipline-leading journals *AAAG*, *Nature*, *Science* and *TIBG* (n=34) during this REF cycle.
- To enhance the international reach and influence of our research.** This was enabled by substantial growth in externally funded international collaboration, Open Access commitments that have increased visibility and uptake of our research, and improved university support for international networking. 41 of the world's best researchers engaged in GYE-led programmes under CALIBRE's 'Institute for Advanced Studies', including Nobel Prize winner Venki Ramakrishnan on migration. Examples of success in improving reach and influence include major reports for high profile international partners such as the UN, UNICEF and World Bank and over 600k downloads of the paper 'The emergence of heat and humidity too severe for human tolerance' (*Science Advances*, 2020) which places it in the top 0.01% of 16.4M papers for visibility, according to Altmetrics.
- To achieve an inclusive research environment that encourages research aspiration and develops researchers to deliver excellence at all career stages.** All staff receive at least one-third of their time for research and EDI champions were appointed to all management teams. Success is evidenced by 90% of eligible staff achieving promotion; attracting outstanding Early Career Researchers (ECRs) who identify as female to prestigious UKRI-NERC Future Leader and Royal Academy of Engineering fellowships (worth £1.5M); and five AAG-EGU-RGS medals awarded to four female and one BAME colleague.

The Strategy inspired significant achievements across all research themes:

### **Cities**

- Strengthened the theoretical base of global urban studies, generating new conceptual and methodological approaches for analysing cities and regions – recognised with the international Jim Lewis Prize for innovation in urban studies.
- Successfully incorporated extreme weather events into city planning and service provision in West African megacities, in innovative GCRF research combining human and physical geography methodologies.

**Children, Youth and Families**

- Challenged liberal founding conceptions of children's geographies via post-structuralist feminist critique, pioneering a politically-progressive conceptual framework and producing landmark research – recognised with two RGS-IBG Gill Memorial Awards.
- Completed the first geographical analysis of the UK Government's £297M flagship National Citizen Service youth programme directly leading to policy improvements.

**Climate-Water-Energy**

- Developed 'social energy systems' approaches in which FCDO invested >£75M via the GYE-led Modern Energy Cooking Services (MECS) and Climate Compatible Growth (CCG) programmes.
- Provided EDF, European Bank and Asian Development Bank with climate risk modelling and novel climate change adaptation techniques, now adopted within individual projects worth \$60-500M.

**Hydroclimate, Risks and Resilience**

- Led the 'compound event' paradigm for understanding how multi-hazards significantly impact the modelling of hydroclimatic risk, including financial risk.
- Co-led installation of an automatic weather station network on Mount Everest (including the highest station on land, 8430m) which is providing rare measurements from Himalayan snow accumulation basins indicating substantive and unexpected sensitivity to climate warming.

**Migration and Nation**

- Delivered state-of-the-art theoretical advances for conceptualising migration across six *TIBG* papers, transforming understandings of how powerful migration forces and ideas about migration and 'nation' affect contemporary societies.
- Challenged popular conceptions of human trafficking leading to work with UNICEF which produced the first ever guide for professional football clubs about child trafficking and protecting children's rights.

**Understanding and Managing Environmental Change**

- Produced global assessments of carbon sequestration in aquatic systems which showed that lake carbon burial offsets 20% of global freshwater CO<sub>2</sub> emissions.
- Revealed the importance of high latitude dust for the Earth system by quantifying global sources of mineral aerosols – recognised with the EGU Ralph Ager Bagnold medal.
- Published the earliest securely dated palaeoecological evidence for *Homo sapiens* in Arabia.

**1.3 Enabling and Facilitating the Achievement of Impact Arising from Research**

Our "inclusive approach to achieving impact from research" was commended in REF2014 and continues to underpin our approach. The Research and Impact Strategy includes a fourth objective:

- (iv) **To increase the commercial, policy and wider impacts of our research.** Delivery of the objective is evidenced by, for example, establishment of an international flood modelling spinout company, *Previsico*, recognised as Leicestershire Innovator of the Year 2020.

This objective has been facilitated by new structural developments including incorporation of enterprise (impact) goals into staff PDRs and the merger of Research *and* Enterprise functions into single entities across the University and SSH. The objective encapsulates and extends the three Impact objectives specified in our REF2014 strategy, which ensure that impact is treated as an integral part of research.

- a) **To design research that matters**, we have supported all staff to develop the significance of their research beyond academia, initially via an Impact Working Group supported by the National Coordinating Centre for Public Engagement, and subsequently with Professor Mark Reed (*Fastrack Impact*) via annual workshops and one-to-one mentoring. Indicators of

success include securing £4.8M in competitively awarded external funding for impact acceleration activities, an AHRC Knowledge Transfer Partnership, and competitively awarded EPSRC and Higher Education Innovation Fund (HEIF) impact accelerator grants for 11 staff.

- b) **To co-produce knowledge**, we emphasised partnership development and provided up to 25% additional workload allocation (2000 hours/year across the Unit) for engagement with our most promising partners, including those associated with ICSs. This resulted in co-developed research and co-authored outputs with the World Bank, UNICEF and Smithsonian Institution. In addition, we supported individual staff to undertake substantive knowledge exchange activities, including three years of 75% buyout for Hillier's NERC Knowledge Exchange Fellowship, working with (re)insurers and the Bank of England on the financial risk of multi-hazards.
- c) **To ensure our UKRI research has greater impact**, we worked with Loughborough's Partnership Development Managers to better connect our UKRI-funded research to impact, opening new pathways to impact beyond consultancy, which characterised our reported impact in 2014. From <£200k industry and government funding in 2014, we used UKRI research to leverage >£4M from industrial and government partners.

Our Impact Case Studies have been enabled by this approach and the broader research strategy.

- ICS1** *Achieving access to affordable, reliable, sustainable and modern energy for all* is based on *research that matters*: the provision of safe, low-carbon energy to some of the world's most marginalised people. *Co-produced* within the academic and practitioner crucible of the Low Carbon Energy for Development Network, ICS1 developed impact from three UKRI-UK Government projects (£828k), which successfully levered greater impact when FCDO invested £39.8M in the MECS programme (21% direct research income, 84% managed) to support UN Sustainable Development Goal 7.
- ICS2** *Adapting water and energy infrastructure to climate change* is underpinned by globally significant research that addresses how organisations responsible for water and energy futures can adapt to climate change. Wilby undertook three 30-day secondments with the Asian Development Bank to *co-develop* decision-making procedures for designing water and energy infrastructure under climate change and provide embedded training for project engineers and technical teams. ICS2 also contributed to our objective of increasing the commercial impact of our research because it has been adopted within individual projects worth \$60-500M.
- ICS3** *Surface water flood nowcasting* is also underpinned by *research that matters*: the prediction of urban floods and their impacts, for example on emergency service response times. It has also increased the commercial impact and international reach of our research by establishing *Previsico* – a spinout company now employing 18 people in the UK and Hong Kong. ICS3 created impact from UKRI funding via NERC research awards (£490k) that enabled three Innovate UK grants (£227k), HEIF funding (£100k) and a £700k loan from Innovate UK to support commercialisation.

#### 1.4 Research and Impact Objectives and Plans for the Next Five Years

Our new strategy will extend our growth since 2014, translating this into bold and sustained achievement. To deliver this vision, we will launch our **ASPIRE** (Achieving Success: Partnerships, Influence, Reputation, Equality) **Research and Impact Strategy** in Spring 2021. Four interrelated sets of objectives will deliver step-changes that move significantly beyond past achievements.

##### Partnerships:

**To accelerate the creation of new geographical knowledge, understanding and impact by strengthening partnerships with key collaborators and beneficiaries of our research.** We will develop stronger academic and non-academic partnerships, extending recent success by:

- (i) Identifying and applying best practice from our most successful non-academic partnerships (e.g. with FCDO, Asian Development Bank) to create sustainable partnerships across all research themes, for example by the strategic appointment of stakeholders to Visiting Professor and Fellow positions.
- (ii) Fully contributing to Midlands Innovation's new social science focused theme, Inclusive Transformations.
- (iii) Building on successful academic partnerships (e.g. in children's geographies with NUS, and geographies of education with Heidelberg) to strategically partner with outstanding international researchers and Centres of Excellence across the world, especially in the Global South (e.g. the University of Ghana).

**Influence:**

***To have greater agenda-setting influence over the direction of geographical debates, impact and research practices.*** We will exert greater agenda-setting influence by:

- (i) Incentivising research leadership, for example by leading on more large-scale, multi-institutional, interdisciplinary research programmes, producing discipline-shaping research monographs and delivering major international policy interventions.
- (ii) Establishing the Centre for Sustainable Transitions: Energy, Environment and Resilience (STEER), capitalising on recent success in the *Climate-Water-Energy* theme to secure a world-leading centre with global influence. We will leverage the £75M combined FCDO investment in the MECS (2019-2024) and CCG (2021-2025) projects to secure additional research and impact funding, and integrate relevant work from colleagues in GYE and elsewhere in the University, to provide broader intellectual underpinning and new multidisciplinary opportunities around climate change adaptation, resilient transformation, humanitarian engineering and water-tower hydrometeorology.

**Reputation:**

***To grow our reputation as a place of excellence that is attractive to researchers at all career stages.*** We will improve our global reputation by:

- (i) Increasing the number of prestigious externally-funded research fellowships that we host. The intent here is indicated by two noteworthy fellowships that are now underway: *Enhancing Community Energy Resilience in Developing Countries* (To, Royal Academy of Engineering, £464k, 2018-2023); *Stuck in the Mud: Addressing the Fine Sediment Conundrum to Support Global Freshwater Biodiversity* (Mathers, UKRI-NERC, £1.1M, 2020-2024). We aim to secure such fellowships across all career stages, including senior fellowships.
- (ii) Fostering the most exciting new research talent by maintaining our excellent contribution to CENTA (ranked first of ten NERC DTPs when re-accredited in 2019) and striving to ensure human geography is recognised as part of an ESRC DTP in 2023.
- (iii) Maximising the visibility, accessibility and uptake of our research through a coordinated action plan for the advancement of open and FAIR access, supported by School and University initiatives.

**Equality:**

***To ensure geographical knowledge is diverse and representative by integrating and embedding EDI in all aspects of research and impact.*** Our REF submission is testament to GYE's inclusive research environment in which all researchers flourish, but persistent challenges across organisations and society require us to expand our ambition further.

- (i) We secured the Athena Swan Bronze Award (2019) and will work towards achieving the Silver Award (2022) by implementing our Action Plan, including all staff agreeing EDI objectives in PDR from 2021. Objectives will enhance personal understanding of EDI and (for those in leadership positions) will require implementation of strategies promoting greater diversity of outcome, for example in recruitment and promotion processes.
- (ii) Externally, our priority is to redefine the international expansion of our research to fully globalise and de-colonise our research priorities and networks. We will incentivise collaborative research with partners in the Global South by prioritising this in Research

Fellowship and seedcorn support. Indicative of capacity and intent is that 60% of our recently awarded projects involve equal partnerships across the world, including our first-ever links to Cambodia, Fiji and Myanmar, and our MECS and CCG projects with FCDO are embedded in the Global South.

### 1.5 Open Research

Loughborough is a pioneer of the 'Open Agenda' and GYE is a leading contributor to the University's high ranking for percentage outputs available open access, e.g. ninth in the CWTS Leiden World Ranking. We have actively supported Repositories for text-based outputs since 2005 and data since 2015, working beyond funder (including REF2021) open access requirements. GYE has deposited 100% of REF2 outputs and, in line with our landmark Open Research Position Statement, 100% of our 2020 journal articles are in Loughborough's new unified Research Repository. Our distinctive contributions include open provision of hourly meteorological data from the highest weather stations in the world on Mount Everest, and the Global Electrification Platform (open-source energy, resource and spatial electrification planning) developed by Howells with the World Bank and Google.

### 1.6 A Culture of Research Integrity

Loughborough University's Code of Research Practice aligns with UUK's Concordat to Support Research Integrity. All new research projects are approved by the Research Director and University Ethics Approval Committee. We actively promote a culture of challenging poor practice. In 2020, we supported a colleague's successful challenge to two leading international journals about unethical citation in which they were the victim. We also operate an Authorship Policy to ensure proper recognition of contributions to outputs and grant applications. We are proud that our work with partners in the Global South is routinely recognised with first authorship for international co-investigators and appointment of local researchers.

GYE staff inform and define the standards for the discipline. Clifford is lead-editor of *Key Methods in Geography* (3<sup>rd</sup> Edition, 2016), while our expertise in *Children, Youth and Families* and *Cities* has led to sub-disciplinary collections on the ethical complexities of 'doing' geographies of young people and globalised urbanisation, respectively. In physical geography, Wilby co-authored the World Meteorological Organization White Paper, *Toward an Ethical Framework for Climate Services*, and Rice led EC-funded research (Hydralab+) investigating husbandry standards for animals and plants in ecohydraulic experiments.

## 2. PEOPLE

### 2.1 Staffing and Recruitment Policy

All academic staff contribute to teaching, research and enterprise activities. We expect and incentivise collegiality from the earliest career stages. All academic staff in GYE have open-ended contracts. In line with sector norms, most research staff are on fixed-term contracts associated with funded projects and we had one independent researcher on a fixed-term postdoctoral fellowship. Part-time working is welcomed with four staff (2F/2M) on fractional contracts, agreed at their request.

Achievement of our strategy objective for an inclusive research environment that develops researchers to deliver excellence at all career stages is evidenced by overall growth and excellent staff retention. In 2014, GYE returned 100% of eligible staff (30.2 FTE), meaning 36 staff in this return (34.4 FTE) represents real growth of 14%. Except for three retirees, all staff who held open-ended contracts in REF2014 are returned here.

Since REF2014, the approach to recruiting excellent staff at all career stages has radically changed, driven by University Strategy. Under 'Excellence100', recruitment shifted to an institution-wide campaign focussed unequivocally on excellence, rather than piecemeal replacement hires. This principle is now embedded in our biannual recruitment rounds, managed centrally with significant School and Unit input, which deliver international recruitment and improved diversity.

GYE regularly assesses its succession needs and uses new appointments strategically to ensure critical mass and leadership across the six research themes. We made 13 open-ended appointments of whom five were recruited internationally. To secure leadership in key areas, we appointed two Professors (Clifford, Howells). Reflecting a long-standing commitment to appointing and developing outstanding ECRs, we hired nine Lecturers (Baddock, Baynes, Cranston, Esson, Lulle, Matthews, Slater, Watson, Van Meeteren), two Research Fellows to positions transitioning to open-ended posts (Vice Chancellor's Research Fellowship, Vradis, and Royal Academy of Engineering Fellow, To) and a 2-year Doctoral Prize Fellow, Woodget. Since the census, our NERC Future Leaders Fellow (Mathers) took up her post on an open-ended contract, which demonstrates commitment to the long-term development of outstanding ECRs.

Recruitment has balanced the staff profile (22% Lecturer/Postdoctoral Fellow, 23% Senior Lecturer, 17% Reader, 38% Professor) and with only one colleague reaching the traditional retirement age in the next five years, we have confidence in our capacity to deliver ASPIRE.

## 2.2 Staff Development

Loughborough's Organisational Development offers a wide spectrum of training opportunities and support for staff at all career stages.

Following the principles of the *Concordat to Support the Career Development of Researchers*, Loughborough provides structured **support to postdoctoral researchers** for career progression and development, including preparation of applications for funding. Postdoctoral researchers have a 6-month induction process with monthly mentoring meetings, clear project and developmental objectives, and training. As full staff members, research staff are represented at GYE meetings and have priority access to seedcorn funding. A trebling of research income has seen significant growth in postdoctoral researchers and research fellows – we hosted six postdoctoral fellows (compared with one for REF2014) funded by the British Academy, Royal Society (Newton), Royal Society of Engineering, UKRI (NERC) and Loughborough (x2). In 2019, the SSH Researcher Forum was established to further support this group.

Support for career development, including via the Careers Network, has resulted in five researchers securing lectureships in the UK and overseas, while the increased commercial and policy impact of our research enabled others to move into industry and organisations directly related to their research – including Natural England, National Oceanography Centre, and MoD.

Under the **New Lecturers Programme (NLP)**, staff are guided by an experienced, trained academic adviser. NLP was substantially revised in 2017 and again in 2020 to incorporate the Academic Professional Apprenticeship Level 7. It covers the full spectrum of research and impact activity. New lecturers have a reduced workload in teaching and administration (33-50-67% in consecutive years), which enables the establishment of a full academic profile in research, teaching and impact at a manageable pace. In addition to an extensive training programme leading to FHEA and APA Level 7, the new lecturer meets four times annually with their Adviser. SSH provides a funded PhD student with an experienced co-supervisor. Supervision is a requirement to pass the programme, alongside a minimum expectation of high-quality research outputs and submission of at least one substantial grant application.

NLP is the primary route by which **ECRs are integrated into our research culture**. In SSH, the competitive seedcorn fund is an additional mechanism where ECR participation (and increasingly leadership) is a primary criterion for funding. This support has delivered significant funding successes including Mills (ESRC Future Leaders Grant, £250k), van Meeteren (2 ESRC grants, £202k) and Matthews (H2020, £165k) during NLP; and Vradis (British Academy, £252k) and To (GRCF, £90k) as Research Fellows.

As careers develop, we expect broader leadership contributions. **For mid-career staff**, Unit leadership roles serve as developmental opportunities towards more senior leadership and include: Head of Unit (Holt), Research Director and Doctoral Programme Lead (Harrison), Enterprise Director (Yu) and NERC DTP Lead (Ryves). GYE staff have led the School research agenda as Dean (Clifford, Smith) and Associate Directors for Research (Rice) and Enterprise (Smith). We also encourage election to University committees, such as Senate (Holloway) and Council (Jöns), and institutional leadership roles, such as Global Challenges (Wood), GCRF (Gough) and Climate Change Strategy (Wilby).

We **value the contributions of our five technical staff** (3F/2M) and actively participate, via Midlands Innovation, in the nationally recognised 'Technicians Forum'. Loughborough is a founding signatory of the Technician's Commitment to enhance career opportunities. We engage technical staff in research via PDR development objectives that have led one technician to undertake a funded, part-time PhD and to others being co-authors on outputs.

All members of post-NLP staff in the Unit have an **annual PDR**. This University scheme was overhauled in 2017. A one-to-one discussion with a trained reviewer agrees individual performance and development objectives on the full range of activities including CALIBRE-aligned goals for research and impact. PDR is a transparent way to recognise performance exceeding expectations with additional financial **reward** and allows better support for career development and identifying staff for promotion. The new scheme has particularly benefitted our research staff, guaranteeing regular, formal developmental discussions and providing a structure for pay reward.

The University also revised the criteria for **academic promotion** to ensure that the research components align with the University Strategy and CALIBRE. Criteria now place emphasis on quality, not quantity. Evidence can be based on research, teaching, enterprise (impact) or any combination to encourage balanced portfolios of work. Our strategic objective of developing researchers to deliver excellence at all career stages has seen 90% of eligible academic staff achieve at least one promotion, with five staff achieving two promotions (3F/2M). Staff development is therefore at the heart of what we do, with three-quarters of current Professors and Readers joining GYE as Lecturers.

Staff can apply for **research and impact leave** under University or School Fellowship schemes, which allow focus on exceptional activities for a fixed term. Since 2014, 18 (6 of 12 female, 12 of 24 male) GYE staff have received School Fellowships, including all staff on fractional contracts. Five staff were awarded University Fellowships (up to 1 year, with £5k funding). Fellowships enabled Anderson to take up the prestigious King Carl XVI Gustaf Professorship at Umeå University, Yu to establish *Previsico*, and Brown to co-develop the MECS programme. In total, 99 months of dedicated time for research and impact have been awarded.

### 2.3 Research Students

PhD students are partners in our research and expanding their contribution was key to meeting our objective to deliver excellence at all career stages. PhD awards have increased by >30%, with a completion rate of 93%. Between the 2017 and 2019 Postgraduate Research Experience Surveys, 'overall satisfaction' rose from 82% to 91%. These figures are +7 and +12 on the national average for Geography and the highest at Loughborough, underlining our contribution to

Loughborough's Times Higher 'Excellence in Registry Services' Award (2019) for "transforming the research student experience".

**Funding** to maintain the Unit's PhD population is from University scholarships (£1.7M), UKRI funding, external partners and high-quality self-funded students. We attract high-calibre research students via the Central England NERC Training Alliance (CENTA), which received the highest rating of all NERC DTPs when re-accredited for 2019-2024. 19.5 research students (one iCASE) are NERC funded, with other external funders including EPSRC, China Scholarship Council, Environment Agency, Royal Academy of Engineering and the Turkish Government.

**Recruitment** of research students has shifted from small ringfenced allocations to competitive annual rounds, where the emphasis is on identifying excellent research potential. Candidates must demonstrate they can undertake sustained independent research. Adverts prioritise areas of strategic importance and encourage applications from under-represented groups. Recruitment since 2014 reflects our commitment to EDI: 48% identifying as female; 29% international; 10% of colour (of whom 80% were fully funded, 20% part-funded).

The Doctoral College, School and Unit run complementary inductions for all new starters.

**Monitoring and support** ensures each research student has two internal supervisors with monthly meetings recorded via the University's online Co-Tutor tool. To promote interdisciplinarity, we actively encourage co-supervision across and beyond SSH: 23% of PhD awards had a non-GYE Loughborough supervisor and 18% had external supervisors from public or private organisations. Research students are supported by the Research Director and Doctoral Programme Lead (working under a School Director of Doctoral Programmes). Progress Review Boards meet every 6 months and progression is decided at annual reviews, based on a report and viva with an independent assessor.

Extensive **skills development** opportunities include 200+ events annually from the Doctoral College, from induction and international orientations to major events such as the Annual Conference. The training programme for GYE students is a minimum 30 days (45 for NERC) and we have allocated more than £150k in individual research allowances to support additional research skills since 2014. GYE hosts Annual Postgraduate Conferences and Quarterly Research Student Forums. External training is provided via the NERC CENTA DTP and ESRC Advanced Research Methods Institute which GYE staff contribute to, and all NERC students undertake a mandatory non-HEI placement.

All research students can develop teaching skills but workloads are managed. This enabled them to publish 133 articles in academic journals (89 as first author), hold significant leadership roles (BSG Postgraduate Representative, RGS Postgraduate Annual Conference Coordinator) and win independent external research funding (largest single award £45k). Success is found in our research students' destinations, with 60% staying in academia (including 12 lectureships and prestigious postdoctoral positions at Amsterdam, ETH Zurich and Cornell) and others taking up research related positions with the Environment Agency, TfL, Severn Trent, Atkins Global, AECOM and GEC.

## 2.4 Equality, Diversity and Inclusion

Alongside engagement with nationally recognised schemes (Athena Swan, Race Equality Charter, Stonewall Diversity Champion), GYE's commitment to supporting EDI is widely recognised: Holloway received the 2020 School EDI Champion Award for her work supporting staff with protected characteristics; Esson's leadership on issues of race within British geography was recognised with a 2020 RGS Award, his research on the BAME student attainment gap was shortlisted for a 2020 CALIBRE Award, and he is academic lead on the University's Race Equality Charter Working Group.

Our staff have played a leading role in an institution-wide culture change with respect to EDI. Since 2014, 6 of 13 (46%) new academic appointments have been women. Overall, 12 staff identify as female (10.8 FTE, 31%) and 24 as male (23.6 FTE, 69%), with female staff accounting for a higher proportion of internal promotions (9 of 12, 75% promoted) compared with male staff (13 of 24, 54%). We have nine BAME staff, three of colour (one in 2014), and those who were eligible all achieved promotion.

Funding is available for female staff to attend the Aurora Leadership Programme and female colleagues hold key leadership positions: Research Director, Head of Unit, and GCRF Lead. External leadership positions include President of the International Society for Aeolian Research, Chair of the British Society for Geomorphology, Editor-in-Chief of *Children's Geographies*, and Chair of the History and Philosophy of Geography and Geographies of Children, Youth and Families RGS-IBG research groups.

28% of staff (5F/5M) have **flexible working arrangements** ranging from compressed hours to specific working days/hours, fractional contracts and remote working. Remote working is facilitated through the remote working portal and choice between desktop computer or laptop. Four colleagues (2F/2M), whose requests to move to fractional contracts were granted, are thriving as demonstrated by notable research success – Hillier's NERC Knowledge Exchange Fellowship, Mavroudi's Leverhulme Trust Fellowship – and all achieved promotion.

Conference attendance and other necessary travel to support research is facilitated for **staff with caring responsibilities, ill health or disabilities** by a contribution of up to £200/year towards caring costs. We have also increased the number of international events hosted in Loughborough to 40, welcoming over 1500 researchers, to offset the challenges of travel.

Unit-level data on **funding applications and awards** analysed by protected characteristic is reviewed quarterly by SREC, which includes the School EDI lead, with any concerns addressed via the School Research Action Plan. For example, significant gender differences in success rates and average grant size were observed prior to 2016-2017. With additional support, grant success for female PIs doubled to 40% and average application value tripled to £300k, removing both gaps by 2019-2020.

**Support for the wellbeing of staff and research students** has been strengthened with four new School-level roles: Director of Academic Staffing, professional Wellbeing Advisor, dedicated HR partner and Doctoral Research Culture Champion. GYE has three mental health first aiders and Loughborough offers support services including Counselling, Occupational Health and an Employee Assistance Programme (also available to research students). The benefits are reflected in high staff retention and low postgraduate dropout.

**Staff and research students returning from periods of leave** are supported by the Head of Unit and Director of Academic Staffing and receive a reduced workload for one semester. Mavroudi's return on a fractional contract was supported with a School Fellowship leading to a Leverhulme Trust Fellowship. Pimlott-Wilson's supported return was followed by a Leverhulme Trust award (£191k), RGS medal and double-promotion. GYE staff instigated an institutional policy for research student maternity returners (2018).

**Support for staff with protected characteristics** is now embedded in all processes. Workload is reviewed annually with respect to protected characteristics by the Head of Unit and Occupational Health. Recommendations for staff with disabilities are supported fully. Individual circumstances, including caring responsibilities, are formally considered in promotion criteria and performance assessments.

## 2.5 EDI in our REF submission

Our REF Leadership Group comprised six staff (3F/3M, female lead), a wider group reviewing outputs (4F/7M) and four external advisors (2F/2M). All undertook additional REF-specific EDI training. Output and ICS selection was based on a single criterion: excellence. A confidential University-wide procedure saw staff report circumstances that may have affected their ability to research productively throughout the REF period. An extensive programme of Equality Impact Assessments was conducted on committee / team memberships and output selection, which showed no evidence of bias. We are proud that the attribution of our REF2 outputs matches the REF1a profile:

|              | <i>Gender<br/>(F/M%)</i> | <i>Fractional<br/>contracts (%)</i> | <i>Postdoctoral-Lecturer/Senior<br/>Lecturer/Reader/Professor (%)</i> |
|--------------|--------------------------|-------------------------------------|---|
| REF1a staff  | 31/69                    | 11                                  | 22-23-17-38   |
| REF2 outputs | 30/70                    | 11                                  | 23-20-16-40   |

## 3. INCOME, INFRASTRUCTURE AND FACILITIES

### 3.1 Research Funding and Strategies

We identified growth in research funding as key to meeting our objective of producing research at the forefront of developing new geographical knowledge and research agendas. To achieve this, we used seedcorn funding for early-stage ideas and formalised new research grant quality assurance processes in GYE and SSH, including demand management of strategically important calls, early and ongoing peer review of applications, mock-interview panels and closer engagement with the Research and Enterprise Office. As a result, we grew our research income to £10.5M (+280% on REF2014) and in the same period secured £21.7M in new awards.

The composition of our funding sources has shifted considerably since 2014. We achieved a 175% increase in funding from the UK Research Councils and British Academy, which remains the highest proportion (51%). Our objective to increase the commercial and policy impact of our research delivered a 2677% increase in UK Government funding, confirming public sector and industry demand for our work. Our objective of enhancing international reach delivered a 298% increase in European funding.

Our success includes 16 awards >£200k. Research funding comprises UKRI awards from NERC (30 awards, £3.1M value), ESRC (9 awards, £1.1M), EPSRC (8 awards, £775k), and AHRC (1 award, £115k); and competitive awards from the UK Government (8 awards, £14.3M), British Academy (7 awards, £644k), European Commission (4 awards, £377k), Royal Academy of Engineering (£464k), Leverhulme Trust (4 awards, £374k) and Fritz Thyssen Foundation (£225k).

**Major and prestigious grants** include the £8.3M MECS award (part of the £39.8M MECS programme that GYE leads for FCDO, 2019-2024). This award illustrates how GYE strategy and support has facilitated improved grant success. Following three EPSRC-DFID awards in 2013 (READ, £109k; USES, £259k; SONG, £465k), Brown was awarded a School Fellowship (2014) and salaried support for a Senior Research Associate. This enabled the co-design of DFID's 2016-2019 *Transforming Energy Access Initiative* (£1.1M). Release from teaching (2016-2020) provided Brown with capacity to redesign the UK Government's strategy on low carbon energy transitions within the Global South, directly leading to the FCDO MECS programme.

Across all themes, our strategy to support international networking has proved essential in securing income as part of international **research consortia**: *Water Energy Food: Vaccinating the Nexus* (EPSRC, £1.6M); *Advancing Creative Industries for Development in Ghana* (DANIDA, £1.5M); *TECHNGI – Technology Driven Next Generation Insurance* (ESRC, £1.4M),

*International Rural Gentrification* (ESRC-NSF-ANF £968k), *EXtremeClimTwin – Studying Hydroclimate Extremes in South-East Europe* (Horizon 2020, £806k), *The Origin of Aeolian Dunes* (NERC-NSF, £793k) and *Refugee Youth Volunteering Uganda* (ESRC-GCRF, £787k).

Increased research income has delivered **high-quality research outputs and impact**, for example:

- Anderson's NERC-funded research, published in *Nature* and *Science*, generated the first-ever impact assessment of high-latitude dust derived from glacial melting in lake systems.
- Smith's ESRC-funded research pioneered new international comparative approaches to (rural) gentrification and stimulated a high-profile article and forum in *Dialogues in Human Geography*.
- Yu and Wilby's NERC-funded research, published in *Nature Sustainability*, developed *FloodMap Live*, the world's first real-time, surface water flood, nowcasting technology.

### 3.2 Organisational Infrastructure Supporting Research and Impact

In addition to support from the Research and Enterprise Office (REO), ranging from development of research bids and skills training to partnership development, commercialisation and legal support, we benefit from tailored support at University, School and Unit level.

At University level, CALIBRE led to a reorganisation of the REO (2014) to align with Global Challenge programmes. A dedicated Research Development Manager was appointed to 'Changing Environments and Infrastructure' (CEI, led by Wood), with a remit to support NERC funding applications and service internal demand management. This support delivered 30 NERC grants, including 19 NERC-funded research students, and 3 competitively awarded CEI-funded research students. GYE also benefits from dedicated Partnership Development Managers who support knowledge exchange partnerships, impact generating activities, and funding applications. This support includes competitively awarded EPSRC and HEIF impact acceleration funding. 11 staff attracted £183k which supported our Impact Case Studies and the wider range of impact work detailed in Section 4.1.2.

At School and Unit level, academic staff receive a standard research allowance of £750/year (£168k since 2014), predominantly to support conference attendance, with an uplift to incentivise grant capture. Staff are further supported by internal funding for small-scale, pilot research and impact activities, allocated on a competitive basis. GYE received £75k in 'seedcorn' funding, supporting 24 researchers across 30 projects. Seedcorn projects directly stimulated >£0.5M of AHRC, NERC, and Leverhulme Trust research income; enabled high-profile outputs including Blazek, Esson and Smith's TIBG paper on 'Relational geographies of human trafficking'; and was critical for upscaling Yu and Wilby's real-time flood modelling system (ICS2).

Institutional investment has worked well alongside Unit strategy to deliver growth and success in two research themes:

- *Climate-Water-Energy* was identified as a strategic priority in REF2014. Institutional support for additional staffing, including Howells, fellowship applications, teaching buy-out and a dedicated Research Development Manager, attracted awards totalling £14M. Internal and external investment has grown the team from two research staff in 2014 into a group comprising 15 research and project staff, including a centrally appointed Research Support Leader. This will increase further via CCG, with bespoke office space secured for a new institutionally supported Centre for Sustainable Transitions: Energy, Environment and Resilience (STEER) (2021).
- *Hydroclimate, Risks and Resilience* was supported by a £91k institutional HEIF award to commercialise *FloodMap Live* and by teaching buy-out for Yu. Loughborough University Science and Enterprise Park and business incubator (LU Inc) then provided essential support to develop and launch the award-winning flood-modelling spinout company *Previsico*.

### 3.3. Operational and Scholarly Infrastructure Supporting Research and Impact

Infrastructure developments have been crucial in transforming our environment to support research and impact. A major institutional investment in STEM included a £1.5M investment (2017) to co-locate all staff, postdoctoral and research student workspaces in a single purpose-designed building with state-of-the-art laboratories and computing facilities.

A major part of this investment to support *Understanding and Managing Environmental Change* was in the relocation and refurbishment of the River Science Laboratory (L1), comprising two sediment-transporting flumes, attendant hydraulic measurement infrastructure, and extensive modifications to accommodate aquatic plant and animal husbandry, including aquaria with environmental controls for mesocosm experiments. The RSL is a unique facility for undertaking experimental work in zoogeomorphology and ecohydraulics which made possible leadership of the H2020 Hydralab+ work-package on physiological stress in aquatic plants and distinctive, field-defining investigations into the zoogeomorphic impacts of fish, crustaceans and insects.

Our digital environment facility (L2) comprises a geospatial data library, multi-core computing facility, drones, specialist modelling software and geospatial analysis software. It has been essential for our work in *Hydroclimate, Risks and Resilience* by providing hazard evaluation and forecasting capability that has enabled agenda-setting work on societal impacts of deadly heat, drought and urban flood risks; advanced flood nowcasting and statistical downscaling techniques; and the creation of new models and process understanding of multi-hazards/catastrophes. ICS2 and ICS3 would not have been possible without these digital assets.

In addition, our suite of dedicated laboratories provide: (L3) research-quality microscopes; (L4) a Total Organic Carbon analyser, ion chromatograph, UV-visible spectrophotometer and laser particle sizer; (L5) wet and dry sieving, an aeolian particle abrasion simulator and related facilities for soil, invertebrate and plant sample preparation and analysis; and (L6) a walk-in refrigeration facility for long-term sediment core and sample storage.

These facilities enabled high-quality research, impact and disciplinary development across our physical geography research themes, including:

- Key insights into environmental change from tropical to Arctic freshwaters and new cutting-edge research into Holocene human-environment interactions in coastal Europe (L3, L6).
- The first global assessment of lake carbon sequestration rates over the last 150 years (L4).
- The development of novel biomonitoring indices for the EU Water Framework Directive (L5).

Significant investments have also been made in field assets: (F1) refurbishment of the campus meteorological station; (F2) the 8-hectare Loughborough University Research Forest for carbon-balance studies; (F3) greenhouse facilities for studies of carnivorous plant biogeography; (F4) the Loughborough University Stream Temperature Network (LUTEN); and (F5) the UK Lake Ecological Observatory Network buoy on Rostherne Mere for real-time study of freshwater biogeochemical cycles under nutrient loading and climate change.

Supporting the generation of important geographical knowledge, these facilities have enabled valuable, national and international research and impact partnerships:

- The meteorological station (F1) hosts rainfall sensors used by the Environment Agency for regional flood-forecasting and was used to prepare and test equipment for Matthews' Everest research with National Geographic.
- Our research forest and greenhouse facilities (F2, F3) enabled research assessing how ecosystems respond to global environmental change in collaboration with Harvard Research Forest.
- LUTEN (F4) is amongst the longest-running and densest water temperature sampling networks in the UK (10 years, 36 sites). High-resolution data supported the Environment Agency's *Keeping Rivers Cool* programme for protecting heat-sensitive organisms from climate change.

- The UKLEON buoy (F5) and an array of sediment traps underpinned several high-impact outputs analysing temporal variations in organic carbon dynamics and burial in lake ecosystems.

**Collaborative Research Infrastructure:** Through NERC CENTA and Midlands Innovation, our researchers have access to consortium-wide data-archives and infrastructure. Research into extreme rainfall trends in Europe and in Himalayan weather has been facilitated by atmospheric data from the European Centre for Medium-range Weather Forecasting (ECMWF) and statistical analysis on the NERC JASMIN super data cluster. Linux clusters at the Meteorological Institute of Norway, ECMWF and Oxford have processed climate model archives to reconstruct and appraise multi-centennial climate records and discern trends in extreme weather events.

Access to the UK Arctic Research Station (BAS/NERC) on Svalbard and two research stations under the EU-Interact scheme has led to growth in our Arctic research. Access to the NERC ship James Clark Ross allowed Evans to gather marine geophysical data along the continental margin of west Greenland. Evans' involvement in the 2019 Weddell Sea Expedition revealed how past Antarctic ice shelf retreat was an order of magnitude faster than today with major implications for rapid sea level rise under current global warming (*Science*, 2020).

Installation of five automatic weather stations on Mount Everest have provided Matthews with an unrivalled platform for measuring ongoing climate change across the full elevation range of Asia's water towers.

**Major Benefits-in-Kind:** 7 competitive NERC awards (£132k, including £39k from a £230k NERC Big Data Capital Call) enabled use of NERCs Biomolecular Analysis and Life Sciences Mass Spectrometry Facilities, and Radiocarbon and Isotope Geosciences Laboratories.

#### 4. COLLABORATION AND CONTRIBUTION TO THE RESEARCH BASE, ECONOMY AND SOCIETY

##### 4.1 Research Collaborations, Networks and Partnerships

Our more mature **collaborations** are now associated with large-scale funded programmes:

- Howells leads the CCG consortium, a collaboration comprising Oxford, Cambridge, UCL, Imperial and the Open University, currently delivering the £35M CCG programme (FCDO, 2021-2025).
- Rice co-led the ecohydraulics work for the €10M H2020 Hydralab+ research consortia comprising 33 partner institutions across 16 countries.
- Evans co-led the coring on the Scott Polar Research Institute's 2019 Weddell Sea Expedition, alongside the Universities of Cambridge, Oxford and Cape Town.

Leadership of four international research **networks**, two pre-existing and two new, provided further essential substance in delivering our research strategy:

- **Globalization and World Cities.** Established in Loughborough in 1998, the online GaWC platform – where researchers and practitioners can access 105 research projects, 472 working papers by 284 authors from 37 countries, and open access data – receives >60k visits annually from researchers, students and practitioners in >150 countries. Key partners in the network include the Universities of Bristol, Ghent, Hong Kong and Leuven. GYE has three Associate Directors who organised nine international conferences and workshops, published 10 books and edited five journal special issues in association with GaWC since 2014.
- **Low Carbon Energy for Development Network.** LCEDN (established 2012, Brown) is a platform for academics, practitioners, policymakers and private sector organisations convened by Loughborough University with the Durham Energy Institute. LCEDN includes the Science and Technology Policy Research Department (University of Sussex), Energy

Futures Lab (Imperial College) and the UK Energy Research Centre. LCEDN partners helped GYE deliver £4M in research income and secure £10.4M in awards since 2014.

- Supported by the Leverhulme Trust, Bullard's **High-Latitude and Cold Climate Dust Network** (established 2015) includes the USGS, NASA and University of Washington, and underpinned a NERC grant (£493k) to investigate the ecological effects of glacial dust deposition on remote Arctic lakes. This led to an in-situ briefing in Greenland of the APPG for the Polar Regions about UK science in the Arctic and Loughborough hosting the 6<sup>th</sup> UK Arctic Science Conference.
- **HistGeogUni** (established 2017, Jöns) is a collaboration of 21 universities – including Oxford and Harvard – which is challenging established understandings of the historical geography of the university. Funded by the Thyssen Foundation (€225k), HistGeogUni led to GYE hosting the 3<sup>rd</sup> International Conference on Geographies of Education.

Since 2017, Loughborough's Institute of Advanced Studies has supported new collaborations and networks through competitively awarded annual research themes. GYE has led four of the nine multidisciplinary research themes to date (Migration, Nation, Water, Polar), hosting 41 international scholars as Visiting Fellows alongside events and workshops. We are developing these into sustainable networks to facilitate new research activity.

The CENTA NERC DTP is one of our most important **partnerships**. Ranked first nationally when re-accredited in 2019 as CENTA2, the consortium unites Loughborough, Birmingham, Leicester, Warwick, Cranfield, the Open University, British Geological Survey, Centre for Ecology and Hydrology, National Centre for Earth Observation and National Centre for Atmospheric Science.

Important individual collaborations are sustained through Visiting Professorships and Research Fellowships, including with key partners from outside academia, for example Prudhomme (European Centre for Medium-Range Weather Forecasts and Visiting Professor of Hydroclimatology) who co-authored 10 papers with Wilby (two in *Nature*) and co-supervised two PhDs. Gough's Visiting Professorship at the University of Copenhagen directly resulted in 13 outputs and the £1.5M ACIG project with Copenhagen Business School. Anderson's prestigious Royal Swedish Academy of Sciences, King Carl XVI Gustaf Visiting Professorship at Umeå University enabled international comparative work investigating Greenland-Arctic (Anderson) and Sweden-Siberia (Climate Impacts Research Centre) carbon dynamics.

#### 4.1.1. Key research users, beneficiaries or audiences

Our success has been achieved by developing and quickly upscaling new relationships into major activities delivering impact from research. Key relationships have included working with major international organisations:

- Matthews' relationship with National Geographic began with a fieldwork grant to establish a high-altitude climate measurement network in Ladakh, India. This led to Matthews being the sole UK scientist on the 2019 National Geographic-Rolux Perpetual Planet Extreme Expedition to Mount Everest. The resulting National Geographic documentary promoted our hydroclimatic research to a global audience, while the creation and curation of a major new dataset from the world's highest weather stations places GYE at the forefront of international research assessing high-altitude impacts of climate change.
- Esson's relationships with UNICEF and FIFA were enabled with support from Loughborough University Enterprises Limited. This resulted in a major international report for UNICEF designed to change FIFAs regulatory framework for protecting children's rights in football globally.

We are equally committed to relationships with smaller organisations that challenge convention for societal gain:

- Brown's relationship with Practical Action emerged from a three-day UK Energy Research Centre event in Loughborough. Practical Action joined the LCEDN Management Committee

and collaborated on projects that contributed to a rapid increase in research income and awards, including the £1.1M *Transforming Energy Access 'Partnerships for Skills Development'* programme and MECS.

- Watson's relationship with leading independent music producer, Sentric Music, started from a RGS small research grant on regional music economies, which included an interview with Sentric's Head of Rights Management. Working with Loughborough's Knowledge Exchange team Watson subsequently secured an AHRC KTP and three ESRC CASE studentship with Sentric and TechNation.
- Ryves' collaboration with the National Museum of Denmark was enabled by SSH seedcorn funding that supported development of a multidisciplinary Leverhulme Trust project and led to a *Nature Communications* paper contesting the axiom that agriculture is necessary for the rise of complex societies.

#### 4.1.2 Wider Contributions to Economy and Society

Our inclusive approach to impact has supported **wider activity and impact** in multiple ways.

- **Environmental engagements** include To's membership of the international expert group who produced the 'UN Framework Classification for Resources to Solar Energy' that is delivering improved consistency in the interpretation of solar resource estimates. UK examples include Rice and Wood's research with the Environment Agency (Community Infrastructure Levy, 2016-2023) to test novel strategies for managing invasive crayfish burrowing and associated impacts on flood risk.
- **Technological partnerships** include Hillier's collaboration with reinsurance experts Argo Group, Cat Risk Intelligence and SCOR which translated state-of-the-art catastrophe modelling techniques and technologies into practical knowledge to support industry practitioners and public policymakers in *Natural Catastrophe: Risk Management and Modelling – A Practitioner's Guide*. The ESRC-funded TECHNGI project extended this, resolving behavioural and socio-technical barriers to the adoption of AI technologies in environmental risk insurance.
- **Social welfare** improvements have resulted from Smith's work with the International Town Gown Association, most notably via the *Studentification Guide for North America* which is being used by higher education institutions and city governments to deliver effective integration and management of student populations within residential neighbourhoods. In the UK, Pimlott-Wilson has used her research on school-to-work ambition to transform the life chances of young people from low-income families, inspiring over 400 young people in 2019 alone.
- **Economic engagement** by Watson with Sentric Music is increasing the earnings of Sentric's >100k artists by harnessing social media to generate publishing royalties through a new 'royalty calculator'. Internationally, Hoyler and Esson collaborated with the Council for Advancement and Support of Education to develop new digital resources and training materials for building philanthropic engagement at higher education institutions in Africa.
- In **policy arenas** Wilby was a member of the UK Committee that identified the six priority risks for 2017-2022 in the *UK Climate Change Risk Assessment Evidence Report*; Mills was Parliamentary Fellow on the APPG for Democratic Participation, working with former Education Secretaries Lord Blunkett and Nicky Morgan MP to improve citizenship education in the UK; and Howells partnered with the UN Department of Economic and Social Affairs and UN Development Programme to establish international principles for using 'Modelling Tools for Sustainable Development Policies'.

We have a longstanding history of **engaging with diverse communities and publics**. A distinctive feature is our work with vulnerable and marginalised communities, especially across the Global South. With the launch of GCRF (2015) we capitalised on existing and new links to co-design and deliver major projects. Gough's commitment to longitudinal research and building long-term relationships with low-income communities in Ghana over 20+ years enabled two new projects. Working with local 'Community Champions' to gain access to homes, schools and hospitals, Gough collaborated with Wilby to examine *Vulnerability to Extreme Weather Events*

and establish means of *Reducing the Impact of Extreme Heat to Improve Wellbeing* in African cities. In the *Nutricities* project Vradis worked with community groups in the favelas of Maré (Brazil), improving locally developed food growth and distribution networks to diminish food insecurity and improve wellbeing. Research on marginalised migrant groups has grown at the intersection of our *Migration and Nation* and *Children, Youth and Families* themes: notably, Blazek's work examining human trafficking with Somali refugees in Leicester; Mills' ESRC/GCRF-funded research examining refugee youth volunteering in Uganda; and Lulle who shifted the focus from economically active, to young and aging, migrants. Finally, after developing a 'Media Strategy', GYE partnered with the Public Relations Office to launch Loughborough University's first **12-week themed media campaign on 'Environment'** (2019). Our research featured nationally on BBC and ITV, and internationally on National Geographic. A second campaign on 'Transport' saw postgraduate research on how drones monitor the health of rivers and the impact of climate change gain international media exposure.

#### 4.2 Contribution to the Sustainability of the Discipline

Our contribution is in successfully attracting diverse international audiences to debate major intellectual and practical challenges. Since 2014, GYE has hosted 40 international conferences and workshops, including the *5th International Conference on Geographies of Children and Youth*, *7th Annual Low Carbon Energy for Development Conference* and *6th UK Arctic Science Conference*. Our responsiveness to interdisciplinary research priorities led to the launch of two new international conferences on the *Emotional Geographies of Childhood* and *Migration and Mobilities*, alongside the *3rd International Conference on Geographies of Education* following two conferences organised in the previous assessment period. Our commitment to developing researchers at all career stages saw us host the 2014 *RGS-IBG Postgraduate Mid-Term Conference*.

Unit staff hold 65 national and international leadership roles in key disciplinary organisations, including President / Chair of: the International Society for Aeolian Research and British Society for Geomorphology (Bullard); Scientific Council of the Leibniz-Institute of Regional Geography (Jöns); International Geographical Union – Population Geography Commission (Smith); and, the RGS-IBG Research Groups on Children, Youth and Families (Mills, Pimlott-Wilson) and History and Philosophy of Geography (Jöns). The leadership we offer was further emphasised by Bullard's appointment as the first-ever Chair of the RGS Accreditation Panel for research-informed Geography degree programmes.

Staff also edit two key introductions to geographical research – *Key Methods in Geography* and *Key Concepts in Geography* – and have used their research to sustain the discipline in other ways, including: the RGS-IBG 'Education for Antarctic Conservation' programme made available to all UK schools to connect young people to the Weddell Sea Expedition, where Evans had a leading role; our 'global cities' research featuring in the GCSE curriculum; and Wilby producing the 'Restless Climate' RGS-IBG school resources.

Some of our major **interdisciplinary** collaborations are setting new research agendas. Our physical geography has deep connections to ecology, including research with freshwater, plant and forest ecologists in numerous UK agencies (Environment Agency, Centre for Ecology and Hydrology, Scottish Natural Heritage) and overseas universities (e.g. Melbourne, Harvard). This interdisciplinary research has challenged orthodox disciplinary theory including, for example, biota's role in geomorphological change, and attracted outstanding postdoctoral ecologists (Guareschi to a Royal Society Newton International Fellowship, Mathers to a UKRI FLF) to develop and sustain the evolving subdisciplines of ecohydrology and zoogeomorphology. In the TECHNGI project, Van Meeteren and Hillier have worked with economists, business analysts, technology developers and systems engineers to overcome the barriers to adoption of AI technologies in environmental risk analysis; innovative interdisciplinary collaboration that is strengthening the discipline's methodological toolbox and its connections to industry.

Our engagement with **international priorities** has been substantial. Over £15M in FCDO and GCRF awards to GYE is recognition of our contribution to the UK Government's overseas aid priorities and delivery of commitments towards achieving the UN Sustainable Development Goals. Exemplars include leadership of the wider MECS and CCG programmes (>£75M) alongside three >£250k GCRF projects delivering low-cost solutions to protect communities against extreme weather events, improve urban infrastructure and address food insecurity. All involve large multidisciplinary research teams, including Gough and Wilby who collaborated with health scientists and engineers to manage the public health risks of climate change in West African megacities. To is an engineer working on the first-ever 5-year RAEng fellowship in the social sciences to build more resilient energy systems in Nepal and Malawi.

### 4.3 Indicators of Wider Influence

The influence of our research is evident in our visiting appointments, the journals that Unit staff edit, the special issues we have convened, our activity with funders, the conference organisation we have undertaken, and the prizes and fellowships secured.

We have significantly increased our presence in decision-making roles that influence the future direction of research, for example as Chair of the Academy of Finland's Environment Panel (Anderson) and Vice-Chair Panel D ESRC Grant Assessment Panel (Smith), alongside appointments to 24 review panels and peer review colleges across national (AHRC, BA, British Council, EPSRC, ESRC, GCRF, NERC, UKRI) and international funders (including NSF, NWO).

Staff held leadership roles on the organising committees of five major international conferences, organised 89 national and international events (40 in Loughborough, 49 externally), convened 108 conference sessions (including 33 RGS, 18 EGU, 17 AAG, 4 AGU), presented 498 conference keynotes and papers (including 55 RGS, 47 EGU, 30 AAG, 30 AGU); and delivered 145 invited research seminars.

Our influence in geography extends to the editorial roles staff hold, including leading international journals in our field. **66% of staff serve on scientific journal boards, with nine defining editorial policy as Editor-in-Chief of major disciplinary journals** (Clifford, *Progress in Physical Geography*; Holt, *Children's Geographies*; Gough, *International Development Planning Review*; Howells, *Energy Strategy Reviews*; Rice, *Sedimentology*; Smith, *Geographical Journal*, *Journal of Rural Studies*, *Population, Space and Place*; Wood, *River Research and Applications*). In addition, our convening power has seen staff edit 42 journal special issues, 25 books, and hold editorial positions on major book series including 'Key Ideas in Geography' (Routledge) and the 'RGS-IBG Book Series' (x2; Wiley).

The number of staff holding long-term **visiting positions** has grown significantly: Visiting Professorships at Copenhagen, East China Normal (x2), Federation University Australia, Heidelberg, Hunan (x2), Melbourne, Umeå, UT Sydney; and Visiting Researcher positions, notably at Harvard and NUS.

The award of prestigious **prizes and fellowships** demonstrates sustained excellence and influence, with major prizes predominantly awarded to female and non-professorial staff testament to Loughborough's inclusive environment. Prizes include: the AAG Political Geography Outstanding Research Award (2015, Mills); EGU Ralph Alger Bagnold Medal (2020, Bullard); RGS-IBG Gill Memorial (2017, Mills, 2020, Pimlott-Wilson) and RGS-IBG Taylor & Francis (2020, Esson) Awards. Smith (2016) joined Holloway (2013) as Fellow of the Academy of Social Sciences. External fellowships include: a UKRI Future Leader Fellowship (Mathers); Royal Academy of Engineering, Engineering for Development Fellowship (To); British Academy Fellowship (Pimlott-Wilson); and the Royal Society Wolfson Merit Award (Anderson).